

The Effect of Using Agronutri-X App on The Academic Achievement of Vocational College Students

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Abstract

In this study, the researchers employed the AGRONUTRI-X M-learning application as an intervention tool to assess its impact on the academic performance of participants enrolled in vocational colleges. The AGRONUTRI-X app is a smartphone app designed for Android devices, which has been made available for download on the Google Play Store. AGRONUTRI-X integrates the theories of cognitivism, constructivism, contextualism, and behaviourism as part of its instructional design. The design and development of this app were guided by the ADDIE instructional development model. This study used a quantitative approach with a quasi-experimental design. The sample consisted of 63 subjects, divided into a control group ($n = 31$) and a treatment group ($n = 32$). The study was conducted at two vocational colleges offering a Crop Agroindustry programme. The effect of using the AGRONUTRI-X M-learning app on the topic of fertigation nutrients mix has been evaluated using theoretical and practical academic achievement test instruments. The validity of three experts using the content validity item index (I-CVI) on both research instruments has demonstrated a high level of validity. The reliability of the academic achievement instrument was measured using the inter-rater reliability (IRR) method using Cohen's Kappa statistic; the kappa value obtained was $\geq .75$. The data from the study were analysed using descriptive and inferential statistics, including the mean, standard deviation, t-test, and Cohen's effect size. The mean post-test academic achievement for the treatment group ($M = 84.41$; $SD = 2.87$) was found to be significantly greater than the mean post-test academic achievement of the control group ($M = 61.74$; $SD = 5.78$). The results of the independent sample t-test indicated a statistically significant disparity in the post-test achievement scores between the control group and the treatment group [$t(61) = -19.599$; $p < .005$], with a large Cohen's effect size ($d > .8$). The results of a paired sample t-test indicated a statistically significant difference between the pre- and post-test scores of the treatment group [$t(31) = -29.77$, $p < .005$]. In addition, the effect size, as measured by Cohen's d , was found to be large. The AGRONUTRI-X M-learning app had a

significant impact on the academic performance of the treatment group. This study's results have implications for the practicability and extent of M-learning app integration in vocational colleges.

Keywords: TVET, M-learning, Crop Agroindustry, Quasi-experiment, Vocational College

Introduction

Mobile learning, often known as m-learning, refers to the use of mobile devices, such as tablets and smartphones, as a means to access educational resources and information. Mobile learning is a recent research trend that interests researchers in exploring the effects of its use on students and educators. One of the mobile learning apps that have been developed in Malaysia is the AGRONUTRI-X app. This app is designed for students studying in the Crop Agroindustry programme at vocational colleges, focusing exclusively on the topic of fertigation nutrients mix. This study aims to explore the effect of using the AGRONUTRI-X app on the academic achievement of students studying in Vocational College, especially in the topic of fertigation nutrients mix. Fertigation is an agricultural technique that involves the application of liquid nutrients using a drip irrigation system. This method allows for the controlled delivery of nutrients directly into the irrigation system. The utilisation of this technique is prevalent within soilless cultivation systems, with the term "fertigation" being derived from the combination of the words "fertilisation" and "irrigation". Fertigation fertiliser serves as the primary element within the fertigation technology, wherein the nutritional requirements of fertigated plants are wholly reliant upon the application of fertigation fertiliser (Soman, 2022). Thus, knowledge about the fertigation nutrients mix preparations is very important for students studying in the Crop Agroindustry programme. This study will evaluate the effect of the AGRONUTRI-X M-learning app on the academic achievement of students studying the topic of fertigation nutrients mix.

The study conducted by Suhaimi and Ridzwan (2022) demonstrates that the AGRONUTRI-X M-learning app has effectively accomplished its objectives in terms of expert validity and usability for students studying in the Crop Agroindustry programme at vocational colleges. The findings of this study indicate that the utilisation of the AGRONUTRI-X app holds promise for enhancing academic achievement in the topic of fertigation nutrients mix. Prior research in the field of Technical and Vocational Education and Training (TVET) has demonstrated that the integration of mobile learning technology into educational practices has effectively enhanced student motivation, engagement, and academic achievement. Nevertheless, there remains a dearth of scholarly investigations regarding the impact of utilising mobile learning apps within the field of agricultural TVET, particularly in Crop Agroindustry programmes offered at vocational colleges.

Problem Statement

According to the continuous assessment report conducted at Kolej Vokasional (Pertanian) Teluk Intan, the topic of fertigation nutrients mix obtained the lowest score in comparison to the continuous assessment scores of other topics within the Crop Agroindustry programme. On average, students only scored 70.3%, leading to a B+ grade. As a result, it is difficult for students to obtain an A+ for the Fertigation Fertilisation subject. The current pedagogical approach in vocational colleges continues to rely mostly on traditional textual learning materials, with limited integration of technology-based learning resources to enhance the learning experience. In accordance to the study conducted by Padzil et al (2021), it has been argued that traditional learning methods, which heavily rely on textbooks, written notes, and

instructor instructions, are insufficient in nurturing students who possess the 4C concept, as required by the 21st Century Learning framework. As a result of the teacher's review, the students find it challenging to master the skills due to their inability to identify the types of nutrients found in chemicals and their damaging errors in the practical preparation of formulations. Qurrahman (2017) explained that common errors in the preparation of fertigation nutrients mix are the result of a failure to recognise the chemicals used and an inability to comprehend the fundamental concept of fertigation fertiliser. From the perspective of students, this topic is perceived as challenging due to its incorporation of unfamiliar chemical terminology and the significant focus placed on the precision of experimental procedures. Moreover, the current methods of instruction and demonstration employed by teachers are inadequate in facilitating the mastery of this particular skills by students. The research mentioned aims to examine the effectiveness of AGRONUTRI-X's M-learning app in educating learners in the Crop Agroindustry programme about fertigation nutrients mix. The app has been specifically designed to align with the curriculum standards. It is crucial to evaluate this mobile application as acquiring educational resources on the topic of fertigation nutrition mix is very challenging. Given the complexity of this topic, it is necessary to examine the effectiveness of various learning approaches using the M-learning methodology, which has shown promising results in prior research.

The current student population at vocational institutions comprises individuals belonging to the Z-generation, who exhibit a greater inclination towards and reliance on technology, particularly smart phones. This technological dependency has a discernible impact on their learning styles (Asmawati et al., 2019). In addition, Anuar et al (2021) stated that the TVET field must seize this opportunity so that instructors can implement mobile learning via smart phones for the benefit of students. The educational requirements of generation Z and Alpha, both currently and in the future, require consideration of the digital expectations of these generations. This includes providing learning resources that are up-to-date and align with the expectations of these generations. By doing so, knowledge delivery in various sectors such as public service, education, health, transport, agriculture, manufacturing, energy, and others can be more efficiently achieved (Eşkinat, 2023). Based on a critical analysis of teaching experiences and an extensive assessment of relevant scholarly literature, it is proposed that the incorporation of the mobile learning app AGRONUTRI-X, specifically designed for Android smartphones, be implemented within the classroom setting. This integration aims to enhance the learning process by supplementing current instructional materials.

Objectives

Based on the problem statement and a review of previous research, this study has set two objectives

- i. Identify whether there are significant differences in the post-academic achievement test scores between groups using the AGRONUTRI-X app as support learning material compared to groups exposed to conventional approaches only.
- ii. Identify whether there are significant differences in pre- and post-academic achievement scores among groups using the AGRONUTRI-X M-learning app as support learning material.

Research Question

Based on the two objectives of the research stated above, two research questions were also put forward in an effort to ensure that the objectives could be achieved.

- I. Are there significant differences in post-academic achievement test scores between groups using the AGRONUTRI-X M-learning app as support learning material compared to groups exposed to conventional approaches only?
- II. Are there significant differences in pre- and post-academic achievement test among groups using the AGRONUTRI-X M-learning app as support learning material?

Research Hypothesis

Testing something expected or speculative in a study can be done through a study hypothesis (Lee et al., 2018). In this study, the hypothesis used was in the form of null hypotheses, which are negative statements that indicate no effect on the treatment intervention used. The hypothesis in this study is constructed so that the researcher can run without favouring the treatment intervention used. The null hypothesis built into this study is:

H₀₁ : There is no significant differences in academic achievement scores between groups using the AGRONUTRI-X M-learning app as support learning material, compared to groups exposed to conventional learning only.

H₀₂ : There is no significant differences between pre- and post-academic achievement scores in the use of the AGRONUTRI-X M-learning app as a learning material in the Crop Agroindustry programme.

Importance of the Research

Responsible parties in the field of technical and vocational education will be able to plan policies, practises, and actions for implementing the use of M-learning in the teaching and learning process in vocational college institutions based on the findings of this study. The Fourth Volume of the National Education Policy stipulates that the development of TVET curriculum must be based on student-centered learning. This study can serve as a guide for the Ministry of Education as it develops a student-centered learning strategy approach that is not limited to the Crop Agroindustry Programme only. It can also include other TVET programmes in vocational colleges.

The results of this study can also serve as a reference for all teachers at vocational colleges who teach the Crop Agroindustry programme as part of an initiative to enhance student achievement in the topic of fertigation nutrients mix. Teachers have the option to use the AGRONUTRI-X M-learning app as a supplementary instructional resource alongside their current teaching resources. The prevailing tendency in the field of education seems to prioritise the utilisation of interactive multimedia learning resources. Hence, it is incumbent upon the teacher to employ educational resources that are readily embraced by the current generation of students (Sidek & Hashim, 2016). In the pursuit of enhancing students knowledge and skills, the integration of gadgets has become an unavoidable aspect due to students inclination towards technology (Asmawati et al., 2019). Furthermore, the outcomes of this study will serve as a source of inspiration and ideas for teachers to create and implement M-learning apps in the context of teaching and learning.

This study has importance for students as it aims to assess the effect of utilising AGRONUTRI-X M-learning app on enhancing their academic performance in vocational courses. Furthermore, the outcomes of this research project can serve as a foundation to assist researchers in the field of TVET who intend to explore the utilisation of M-learning apps. These researchers can conduct future research, expanding upon the data and discussion presented in this study.

Literature Review

In an era defined by digital advancements, M-learning has emerged as a transformative force in education. This literature review focuses on the AGRONUTRI-X M-learning app and synthesises insights from previous studies on M-learning in educational contexts. This review contributes to a deeper understanding of M-learning capacity to revolutionise education, with a particular focus on its role in reshaping education and preparing learners for evolving demands and sustainability.

M-learning (Mobile Learning)

Mobile learning, often known as m-learning, is facilitated by wireless devices that enable educational activities to occur beyond the confines of the traditional classroom setting, without being constrained by time limitations. The adoption of m-learning has become prevalent in tandem with the proliferation of smart phone devices and the increased accessibility of internet connectivity (Mohamad, 2023). The existence of M-learning is an extension of electronic learning that has begun to gain a foothold in the world of education widely since the 60s in the United States and rapidly developed throughout the world in the 90s when personal computers and internet access were affordable and reached by most countries in the world. The concept of E-learning is learning based on the use of websites, online learning and computer-based learning (Ruiz et al., 2006). The advent of smartphone technology, which possesses capabilities akin to personal computers, has brought about significant transformations in the field of electronic E-learning, leading to the emergence of M-learning. This shift has been facilitated by the increased accessibility and affordability of rapid internet connectivity. The advent of web-based learning has brought about significant transformations in the field of education, particularly with the emergence of apps that facilitate learning experiences both online and offline, thereby enabling learners to access educational resources at their convenience, regardless of time and location (Hartley & Andújar, 2022). E-learning and M-learning exhibit parallels and interconnectedness as they both fall under the general term of D-learning, which encompasses various forms of digital learning (Basak et al., 2018).

The primary revolution experienced by M-learning in comparison to E-learning pertained to the factors of user-friendliness, mobility, and technological integration (Alenezi, 2023). The significant difference between M-learning and E-learning, apart from their concepts, is their formal and informal approaches to learning. E-learning is frequently employed as a formal learning module, whereas M-learning is frequently employed as an informal learning module to supplement conventional learning (Razak et al., 2022). Furthermore, the inclusion of a wide range of information in M-learning and its utilisation as supplementary educational resources enable students to enhance their skills and knowledge by fostering interest and motivation derived from enjoyable experiences (Rohanai et al., 2022).

AGRONUTRI-X M-learning App

The AGRONUTRI-X M-learning app is a mobile app designed exclusively for educational purposes at vocational college institutions, focusing on the topic of fertigation nutrients mix. The content included in the AGRONUTRI-X M-learning app aligns with the learning standards outlined in the Vocational College Standard Curriculum (KSKV). This app was created based on an analysis of existing problems, a review of the relevant literature, and a feasibility evaluation (Suhaimi & Ridzwan, 2022). The AGRONUTRI-X app is utilised in educational settings at vocational college institutions to supplement and enhance the learning experience both within the classroom and beyond formal instructional sessions. This aligns with the objective of learning in TVET, which not only facilitates learning beyond the confines of the traditional classroom setting but also strives to enhance aspects that are currently absent in conventional learning approaches. The developing of this app was carried out via the MIT App Inventor 2 platform, an integrated online development web application managed by Google.

The AGRONUTRI-X M-learning application incorporates various learning theories, including cognitivism, constructivism, behaviourism, and contextualism. These theories have been carefully tailored to suit the application's purpose as a digital learning resource. According to Thangaiah et al (2020), the use of technology as additional learning material necessitates the guidance of the teacher in order to facilitate active student engagement and knowledge exploration. The best thing about AGRONUTRI-X M-learning app is that it uses Paivio (1971) dual coding theory, which means that it uses both visual and verbal elements through video clips at the same time to help users get better at memory storage. According to Mayer (2001), multimedia theory posits that incorporating visuals, text, and verbal elements in videos can effectively enhance information acquisition at a rapid pace. Furthermore, the simplified interface of AGRONUTRI-X's M-learning app not only contributes to a decrease in the user's cognitive load but also facilitates the gaining of knowledge by aligning with the principles of constructivism (Curum & Khedo, 2020).

The quizzes and activities featured in this application are rooted in the principle of behaviourism, which prioritises the modification of behaviour through ongoing training and exposure (Williams & Anandam, 1973). Positive reinforcement is often regarded as an effective strategy for modifying behaviour and fostering information acquisition. By providing praise or rewards, individuals are motivated to sustain their learning efforts and enhance their academic achievement. According to Rachlin (1991), the utilisation of positive reinforcement in contemporary educational settings serves to encourage student repetition and elicit cognitive stimulation, hence mitigating stress levels. The incorporation of quizzes, questions, and games within the app is an effective approach for users to enhance their engagement in the learning process and encourage the gain of knowledge. A contextual theory that concentrates on the development of learning content that is directly related to the real world is introduced as an extension of constructivism and behaviourism (Berns & Erickson, 2001). Prior to that, Mayer (1999) explained that it is simpler to acquire knowledge if the learning can be directly applied to everyday situations or if it is able to demonstrate to be used practically. The contextual theory in the AGRONUTRI-X M-learning app is implemented into practical exercises as face-to-face training support using multimedia, video, and graphical elements.

Related Studies

Based on the findings of the conducted survey, it has been determined that there is a scarcity of published research articles pertaining to M-learning within the agricultural education

(Yildiz et al., 2020). This observation highlights the limited scope of research conducted on the development and implementation of M-learning apps in the agricultural education, in comparison to other disciplines such as social sciences, humanities, and technology. The current technical advancements hinder the progress of education in the sector of agriculture. In order to support learners and personnel of the agricultural industry in learning new information anywhere and at any time, M-learning should be used as a medium of information distribution and education in the current age of digitization (Vikrant et al., 2020).

Based on the results of the survey, numerous studies on the use of M-learning in technical and vocational disciplines have been conducted and have achieved positive results in various aspects. One interesting study in the subject of Design and Technology (RBT) is the research conducted by (Shah et al., 2019). The findings of the study indicate that the use of the M-learning app has the potential to boost interest and enhance students' understanding of pictorial sketch topics in comparison to traditional instructional approaches. According to researchers, the implementation of M-learning apps in the field of TVET at the secondary level can be feasible, even in the presence of numerous limitations. In relation to the title of this study, previous studies on hydroponics and fertigation were reviewed, and it was determined that numerous studies have been conducted in the discipline of hydroponics and fertigation. Daniel Novianto (2018) has created an M-learning app for hydroponic cultivation as a learning medium. The content validity of the M-learning app was determined to be satisfactory, indicating that this application can be used for learning. The study on the effect of using this M-learning application has also been tested for student achievement through a quasi-experimental. The findings of the conducted study indicate that the group of students utilising the M-learning application outperforms the group employing conventional methods, as evidenced by their higher scores. Taufan Johandri (2020) has conducted research on the utilisation of multimedia in hydroponic learning. The findings of the study indicate that the use of tutorial videos viewed on smart phones outside of class time has helped students perform well in hydroponics preparation practice.

The scarcity of M-learning applications in the agricultural educational field in Malaysia, apart from the AGRONUTRI-X M-learning application, was revealed through a study conducted on the Google Play Store, a prominent search engine and open market platform. This matter is perceived as a window of opportunity for further exploration in the field of agricultural TVET training in Malaysia. The findings of this literature review clearly indicate the need for conducting a study on the effects of using the M-learning application AGRONUTRI-X. This study aims to provide valuable insights not only to researchers but also to other stakeholders involved. Furthermore, this research endeavour would make a valuable contribution to the existing body of literature pertaining to agricultural Technical and Vocational Education and Training (TVET) in Malaysia.

Methodology

This study is quantitative research using pre- and post-test instruments that will generate data in an empirical format to demonstrate the data comprehensively, highlighting differences and findings in terms of cause and effect (Creswell, 2012). Studies conducted in educational institutions do not permit the use of true experimental research design. It is impossible to form new groups and randomly select samples to implement module interventions. Quasi-experimental methodology is seen as the most suitable approach for conducting studies at educational institutions, as it minimises disruption to the pre-existing group. (Isnawan, 2020). This study uses a non-random sampling technique, utilising existing classes. However, the

method of simple random sampling remains to be used for the selection of the vocational college that will act as the research group's location.

This research was conducted at a vocational college that offers an SVM-level Crop Agroindustry programme. Kolej Vokasional (Pertanian) Teluk Intan was selected as the study location for the treatment group using a straightforward random technique, while Kolej Vokasional (Pertanian) Chenor was selected as the study location for the control group. Since the topic of fertigation nutrients mix is included in the curriculum structure of the Crop Agroindustry programme at SVM, only those students were sampled for this study. A simple random sampling technique was used in this study only to determine the vocational college that will be used as the location of the treatment group and the control group. The selecting samples at the study location is based on the existing classes. The results of this study are limited to representing the target group of the study only. Researchers have used existing classes at the location of the vocational college where the study was conducted, involving intervention using the AGRONUTRI-X application together with conventional learning methods for the treatment group and conventional learning interventions for the control group, as shown in Table 1.

Table 1

Sample of the Study

Group	Vocational College	n
Control	Kolej Vokasional (Pertanian) Chenor	31
Treatment	Kolej Vokasional (Pertanian) Teluk Intan	32
Total Sample of the study		63

Instrument

The academic achievement test in this study is based on the topic of vocational courses at the Sijil Vokasional Malaysia (SVM) level, which is tested using two assessment components, which are the theoretical assessment component and the practical assessment component. The weighted percentage for the theoretical evaluation component is 20%, while the weighting percentage for the practical evaluation component is 50%. These results from the theoretical and practical tests will be converted into a weighted 100 score. The process for developing items for the theory assessment uses the test specification table (JSU) to ensure that the assessment aligns with the content of the learning topic. Because achievement tests are the most accurate way to measure student development after exposure to a specific educational module, they are used to evaluate a programme's effectiveness. (Ching & Roberts, 2020). Two sets of tests were used in this study, namely, the pre-test and the post-test. Both sets of tests will use the same test specification table and test the same level of cognitive domains, but differ in terms of the items developed.

The instruments developed in the field of TVET must ensure that the items conform to the standards and evaluations provided by experts (Suhaini et al., 2021). Therefore, the validity of this research instrument is determined using the content validity index (CVI), which involves the agreement index between experts for the items developed (Polit et al., 2007). The instrument's validity was assessed by three experts, and the results indicate that the I-CVI value for all items in the pre-theory test, post-theory test, pre-practical test, and post-practical test is 1.0. The findings from the expert validity assessment indicate that the items

included in the academic achievement test possess a satisfactory level of validity, thus rendering it suited to utilisation in the study.

Inter-rater reliability (IRR) is used in determining the reliability of the academic achievement instrument tested in the pilot study. IRR is used to evaluate the reliability of answers produced by two different items or individuals in the test. The IRR is high if it has a Kappa value above .75, however a coefficient value of .60 and above is an acceptable value in the study (Fleiss et al., 2003; Regier et al., 2013). Analysis using SPSS software version 28.0 was carried out to obtain the value of IRR Cohen's Kappa. The findings of the analysis show that the academic achievement instrument has a good level of reliability, as shown in Table 2.

Table 2

Inter-rator Reliability (IRR) Cohen's Kappa

Instrument	Cohen's Kappa value
Pre-theory test	.806
Post-theory test	.816
Pre-practical test	.75
Post-practical test	.782

Implementation of Study

The study sample was divided into two groups, control and treatment. The control and treatment groups were asked to answer a pre-test to determine the students existing knowledge in the topic of fertigation nutrients mix. The control group will go through the existing conventional learning process in the classroom using written instructional materials. The conventional teaching technique is used for the control group, and the AGRONUTRI-X M-learning app is installed on mobile devices so that students may access supporting learning resources. The duration of the study intervention is six weeks, which matches the period of the implementation of curriculum topics. At the end of the intervention, both groups of students were required to answer a set of post-test questions. The analysis of the results obtained from the academic achievement test was conducted using both descriptive and inferential statistical methods. The statistical software utilised for this purpose was SPSS version 28.0. The specific details of this analysis may be seen in Table 3.

Table 3

Data Analysis Technique

Objectives	Instrument	Data Analysis
1. Identify whether there are significant differences in the post-academic achievement test scores between groups using the AGRONUTRI-X app as support learning material compared to groups exposed to conventional approaches only.	Post-theory test Post-practical test	- Descriptives analysis - Independent sample t-test - Cohen's effect size
2. Identify whether there are significant differences in pre- and post-academic achievement scores among	Pre-theory test	- Descriptives analysis

groups using the AGRONUTRI-X M-learning app as support learning material.	Post-theory test Pre-practical test Post-practical test	- Paired sample t-test - Cohen's effect size
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Data Analysis and Findings

Table 4 below summarises the descriptive analysis of the academic achievement pre-test scores obtained by both study groups. The mean score obtained by the control group was 46.19, with a standard deviation of 5.25. The minimum pre-test score for the control group is 34, and the maximum score is 56. For the treatment group, the mean pre-test academic achievement score was 48.47 with a standard deviation of 6.31. The minimum score recorded is 33, while the maximum score is 62. Table 5 presents the results of an independent sample t-test analysis conducted on the pre-test scores of the control group and the treatment group. The analysis indicates that there is no statistically significant difference in the academic achievement pertaining to the topic of fertigation nutrients mix between the two study groups, as evidenced by a p-value of .126. The obtained p value is greater than the significance level of .05, indicating that there is no statistically significant difference between the two study groups. This has demonstrated that the two study groups are comparable in terms of academic achievement and are suitable for comparative research after the intervention is carried out.

Table 4
Descriptive Statistics Pre-Academic Achievement Scores

Descriptive Statistics	Control Group	Treatment Group
N	31	32
Mean	46.19	48.47
Std. deviation	5.25	6.21
Minimum	34	33
Maximum	56	62

Table 5
Pre-Academic Achievement Independent Sample t-test Analysis

	Levene's Test for Equality of Variances			t-test for Equality of Means				
	Pr	F	Sig.	t	df	Sig. (2-tailed)	95% confidence interval	
							Lower bound	Upper bound
e-test	.46	.359	.51556	1	626	.126	5.208	-.658

Table 6 presents a comparative analysis of the descriptive data pertaining to the post test scores achieved by both the control group and the treatment group in the academic achievement test. The mean score obtained by the control group is 61.74, compared to the higher mean score obtained by the treatment group, which is 84.41. The standard deviation of the post-test of the control group was 5.78, while the standard deviation recorded by the

treatment group was 2.87. The control group recorded a minimum score of 53 and a maximum score of 75. For the treatment group, the minimum score obtained was 79, and the maximum score obtained was 91.

Table 6

Descriptive Statistics Post-Academic Achievement Scores

Descriptive Statistics	Control Group	Treatment Group
N	31	32
Mean	61.74	84.41
Std. deviation	5.78	2.87
Minimum	53	79
Maximum	75	91

Results**Hypothesis 1 Testing**

H_{01} : There is no significant differences in academic achievement scores between groups using the AGRONUTRI-X M-learning app as support learning material, compared to groups exposed to conventional learning only.

The results of the normality test for the independent sample data show that the skewness and kurtosis statistical results obtained are .207 and .461. This value shows normally distributed data with skewness and kurtosis values in the range of -2.00 and +2.00. As a result of the normality test that has been carried out, the independent sample t-test can be used against the data to test the hypothesis.

Table 7

Post-Academic Achievement Independent Sample t-test Analysis

	Levene's Test for Equality of Variances			t-test for Equality of Means					
	F	Sig.	.0	t	df	Sig. (2-tailed)	95% confidence interval		
							Lower bound	Upper bound	
Post-test	7.749	.007	.0	-19.559	61	<.001	24.954	20.374	

The independent sample t-test carried out is based on the first objective of the study, which is to identify whether there are significant differences in the post-academic achievement test scores between groups using the AGRONUTRI-X app as support learning material compared to groups exposed to conventional approaches only. According to the data shown in Table 7, there exists a notable disparity in the mean score of the academic achievement test between the treatment group ($M = 84.41$, $SD = 2.87$) and the control group ($M = 61.74$, $SD = 5.78$). This discrepancy is supported by a t-test result of $t(61) = -19.599$, $p < .001$. A p-value below .05 signifies a statistically significant disparity in academic achievement between the control and treatment groups. The results were derived from the analysis of the independent sample t-test. The null hypothesis was rejected due to the presence of a statistically significant disparity in the mean academic achievement scores between the

group that only received conventional learning intervention and the group that was exposed to both conventional learning and the AGRONUTRI-X M-learning app.

Following the t-test analysis that indicates the presence of significant differences, Jackson (2006) proposes the use of Cohen's effect size analysis to evaluate the size of the significant effect, classifying it as small, medium, large, or very large. The analysis carried out using SPSS 28.0 software resulted in a Cohen's effect size value of 4.987 (very large). This result indicates that the treatment group, which received the intervention involving the AGRONUTRI-X M-learning app alongside conventional learning, exhibited a statistically large effect on academic achievement in the topic of fertigation nutrients mix. In comparison, the control group, which solely received conventional learning, did not experience the same level of improvement.

Hypothesis 2 Testing

H_{02} : There is no significant differences between pre- and post-academic achievement scores in the use of the AGRONUTRI-X M-learning app as a learning material in the Crop Agroindustry programme.

The skewness and kurtosis statistics for the paired sample data of the pre-treatment group test are -.266 and .505. The skewness and kurtosis statistics for the post-test of the treatment group are .461 and -.202. This value indicates that the data is normally distributed, and a paired sample t-test can be conducted to test the hypothesis.

Table 8

Treatment Group Academic Achievement Paired Sample t-test Analysis

	Paired Differences						t	f	Sig. (2-tailed)
	Mean	Std. Deviation	Std. error mean	95% Confidence Interval of the Difference					
				L	U				
Pre-test									
Post-test	35.938	6.829	1.207	38.399	33.475	29.767	1	.001	

The results of the paired sample t-test for the pre-test and post-test of the treatment group are presented in Table 8. The analysis of the paired sample t-test that was carried out is based on the second objective of the study, which is to identify whether there are significant differences in pre- and post-academic achievement scores among groups using the AGRONUTRI-X M-learning app as support learning material. The results of the analysis demonstrate a significant disparity in the mean score of the academic achievement test in the treatment group ($M = 48.47$, $SD = 6.31$; $t(31) = -29.77$, $p = <.001$). A p-value below .05 suggests statistical significance in the disparity between the pre-test and post-test scores when utilising the AGRONUTRI-X M-learning application to improve academic achievement in the topic of fertigation nutrients mix. In conclusion, the null hypothesis stating that there is no significant differences between pre- and post-academic achievement scores in the use of the AGRONUTRI-X M-learning app as a learning material in the Crop Agroindustry programme was successfully rejected. The findings of this analysis demonstrate that the

implementation of the AGRONUTRI-X M-learning app has the potential to successfully improve the academic achievement of students.

To explain the significant effect, Cohen's size effect was utilised again, with a value of 5.262 (very large). This suggests that the use of the AGRONUTRI-X M-learning app as a learning material among subjects in the treatment group has a significant effect on academic achievement in the topic of fertigation nutrients mix.

Discussion and Conclusion

Discussion

This section discusses and summarises the two research objectives and questions stated at the beginning of the study. A discussion was conducted on the effect of using AGRONUTRI-X's M-learning application on academic achievement among the study group.

Are there significant differences in post-academic achievement test scores between groups using the AGRONUTRI-X M-learning app as support learning material compared to groups exposed to conventional approaches only?

The analysis of an independent sample t-test has revealed a statistically significant disparity between the mean academic achievement score of the control group and the mean academic achievement score of the treatment group. There is a notable enhancement observed in the mean post-test scores of the treatment group, which utilised both conventional ways of learning and the AGRONUTRI-X M-learning app as instructional resources, in comparison to the control group that just received conventional learning exposure. The Cohen's effect size demonstrates that using AGRONUTRI-X's M-learning application had a significant impact on improving the student's academic achievement score for the topic of fertigation nutrients mix.

The use of M-learning is not something new in improving the academic achievement of vocational students. In a study conducted by Mahasneh (2020) it was shown that the utilisation of M-learning had a notable impact on academic achievement when compared to a group solely exposed to conventional learning methods. Mobile learning (m-learning), when tailored to meet the specific requirements of students and guided by teachers' utilisation, has the potential to enhance student achievement and foster favourable learning outcomes. This is primarily due to its role as a supplementary resource that complements traditional classroom-based instruction (Klimova, 2019). The aforementioned factors are considered to be contributing factors to the better student achievement scores reported in the treatment group compared to the control group. The utilisation of AGRONUTRI-X's M-learning app facilitates a student-centred approach to education, integrating technology to seamlessly blend in-class and out-of-class learning experiences. The utilisation of M-learning technology has been observed to provide a positive impact on the enhancement of higher-order thinking skills, active and innovative learning, as well as the improvement of student academic achievement. (Azahari & Rahimi, 2022). The analysis of data aiming to compare the post-test scores between the control group and the treatment group has revealed a significantly significant disparity, accompanied by a substantial effect size. Previous research has provided evidence that the utilisation of mobile learning applications results in positive results in terms of students' academic achievements. The present study demonstrates that the use of the AGRONUTRI-X M-learning app as an additional learning material has resulted in positive outcomes in terms of enhancing student achievement in the topic of fertigation nutrient mix, as compared to the control group that just received conventional instructional methods.

Are there significant differences in pre- and post-academic achievement test among groups using the AGRONUTRI-X M-learning app as support learning material?

The observed substantial improvement in academic achievement scores within the treatment group aligns with the finding made by Jamil et al (2021) regarding the beneficial effects of incorporating technology-based learning on student achievement. Descriptive and inferential statistical analysis has demonstrated the significant effect of the AGRONUTRI-X M-learning apps on academic achievement in the topic of fertigation nutrients mix. Previous research studies conducted by Klimova (2019); Prasasti et al (2019); Sukardi et al (2020) have similarly demonstrated the efficacy of utilising M-learning as an educational resource. Numerous studies have demonstrated that the utilisation of M-learning apps has effectively brought positive results in the context of academic achievement and student performance within their respective fields of study. In order to provide a more comprehensive explanation of these research inquiries, it is noteworthy to highlight the substantial improvement observed in academic achievement scores among the group utilising the AGRONUTRI-X M-learning app. This notable outcome has prompted the utilisation of technology that aligns with learning theories that are readily embraced by students, such as cognitivism, constructivism, behaviourism, and contextualism. M-learning technology serves as an additional complement to conventional classroom learning, accessible to students during and outside of set-up learning time (Krismadinata et al., 2020). The role of teachers in encouraging the fulfilment of objectives in M-learning technology is widely recognised. Teacher support and encouragement are crucial factors that contribute to students' engagement in learning and their subsequent acquisition of knowledge. This is achieved through the consistent utilisation of conventional methods of instruction and M-learning apps (Jalinus et al., 2021)

Conclusion

The findings obtained from this study have resulted in positive implications and significant contributions to the realm of technical and vocational education and training (TVET) research. The utilisation of M-learning apps has brought about a transformation in the conventional approach to teaching inside vocational college institutions. Formerly based on a teacher-centred teaching approach, the introduction of M-learning has facilitated a shift towards a more flexible learning environment. This transition is mostly achieved through the integration of additional learning resources that complement the current instructional material. This research demonstrates the successful integration of M-learning within a vocational college setting. This integration effectively addresses various challenges by leveraging the widespread availability of internet access and personal devices. Consequently, M-learning serves as a viable alternative for supporting existing instructional approaches, as it does not necessitate the use of specialised laboratory facilities or costly equipment. The findings from the study of AGRONUTRI-X M-learning app on academic achievement in the topic of fertigation nutrients mix, both in theoretical and practical components, have demonstrated a positive impact. Specifically, the use of the M-learning app has effectively enhanced academic achievement when compared to those who solely engage in conventional ways of learning.

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